Strategic Astrophysics Technology

Development of Formation Flying Sensors

Completed Technology Project (2015 - 2016)

Project Introduction

The Astro2010 Decadal Survey has identified the detection and characterization of an Earth-like planet in the habitable zone of another star as one of the most important science goals for the 2020 decade. Starshades (external occulters) have been identified as the most viable option to achieving sufficiently high contrast close to the star to achieve this feat. To reach the desired contrast at small inner working angles requires flying a starshade in formation with a telescope at a separation of 37,000 km and maintaining cross-track alignment to within 1 meter. Long distance formation flying has been identified as a critical technology in need of development. We propose a low-cost demonstration of two formation flying wavefront sensors that will advance long distance formation flying sensing to Technology Readiness Level (TRL) 6 and overcome the hurdle of this critical technology for a future Earth-imaging mission. The proposed work in this study will demonstrate medium- and fine-level alignment sensors that have been previously identified as potential formation flying sensors for external occulters. The medium-level sensor is an astrometric telescope located on the starshade that guides the starshade as it slews between stars and up to the onset of the shadow onto the science telescope. Once in the shadow, a wavefront sensor on the science telescope uses long wavelength starlight diffracted around the starshade (a phenomenon known as the spot of Arago) to map the distribution of light at the aperture and to guide to the center of the shadow. We will measure recovered intensity from behind the starshade of > 1% at wavelengths outside of the science bandpass and use the measured wavefronts at different wavelengths and starshade configurations to validate model predictions. We will use the recovered intensity to measure position information accurate to -0.25-m, scaled to the size of the spot of Arago and its filling factor in the aperture to proposed mission baselines. We will validate the algorithms estimating the off-axis position in the shadow by positioning the starshade to -1-m from the line of sight, scaled to the same parameters. We will use the astrometric sensor to measure relative positions accurate to < 10-mas and validate algorithms that convert the astrometric signal to a positioning control signal by positioning the starshade to -10-m (scaled to our experiment) from the line of sight. This will be the first demonstration of starshades at wavelengths > 1 micron and will provide a new wavelength regime in which to investigate the starshade's performance and validate state of the art diffraction codes.

Anticipated Benefits

Decadal Survey Missions

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Strategic Astrophysics Technology

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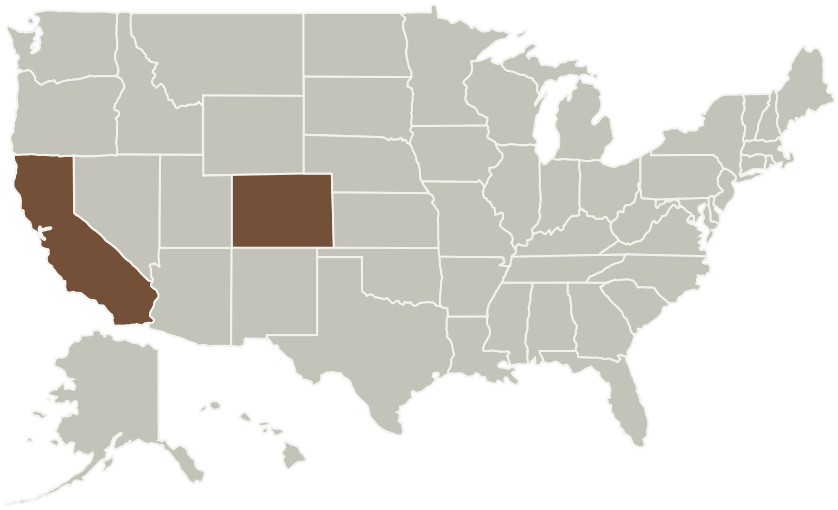
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Northrop Grumman Aerospace Systems(NGAS)	Supporting Organization	Industry	Redondo Beach, California
University of Colorado Boulder	Supporting Organization	Academia	Boulder, Colorado

Primary U.S. Work Locations	
California	Colorado

Project Management

Program Director:
Mario R Perez

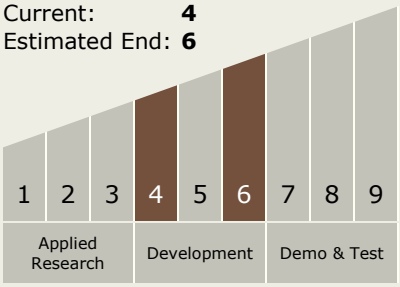
Program Manager:
Mario R Perez

Principal Investigator:
Webster Cash

Co-Investigator:
Anselmo Serralheiro

Technology Maturity (TRL)

Start: **4**
Current: **4**
Estimated End: **6**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.2 Observatories
    - TX08.2.3 Distributed Aperture

Target Destination

Outside the Solar System